The World's Woods

By Maryanna Weir

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THE WORLD'S MOODS

UNIFORM WITH THIS VOLUME

HOW THE WORLD BEGAN
The Story of the Beginning of Life on Earth

HOW THE WORLD GREW UP
The Story of Man

HOW THE WORLD IS RULED
The Story of Government

THE WORLD OF ANIMALS
The Story of Animals

THE GARDEN OF THE WORLD
The Story of Botany

HOW THE WORLD IS CHANGING
The Story of Geology

THIS PHYSICAL WORLD
The Story of Physics

WHAT MAKES UP THE WORLD
The Story of Chemistry

OTHER WORLDS THAN THIS
The Story of Astronomy

THOMAS S. ROCKWELL COMPANY
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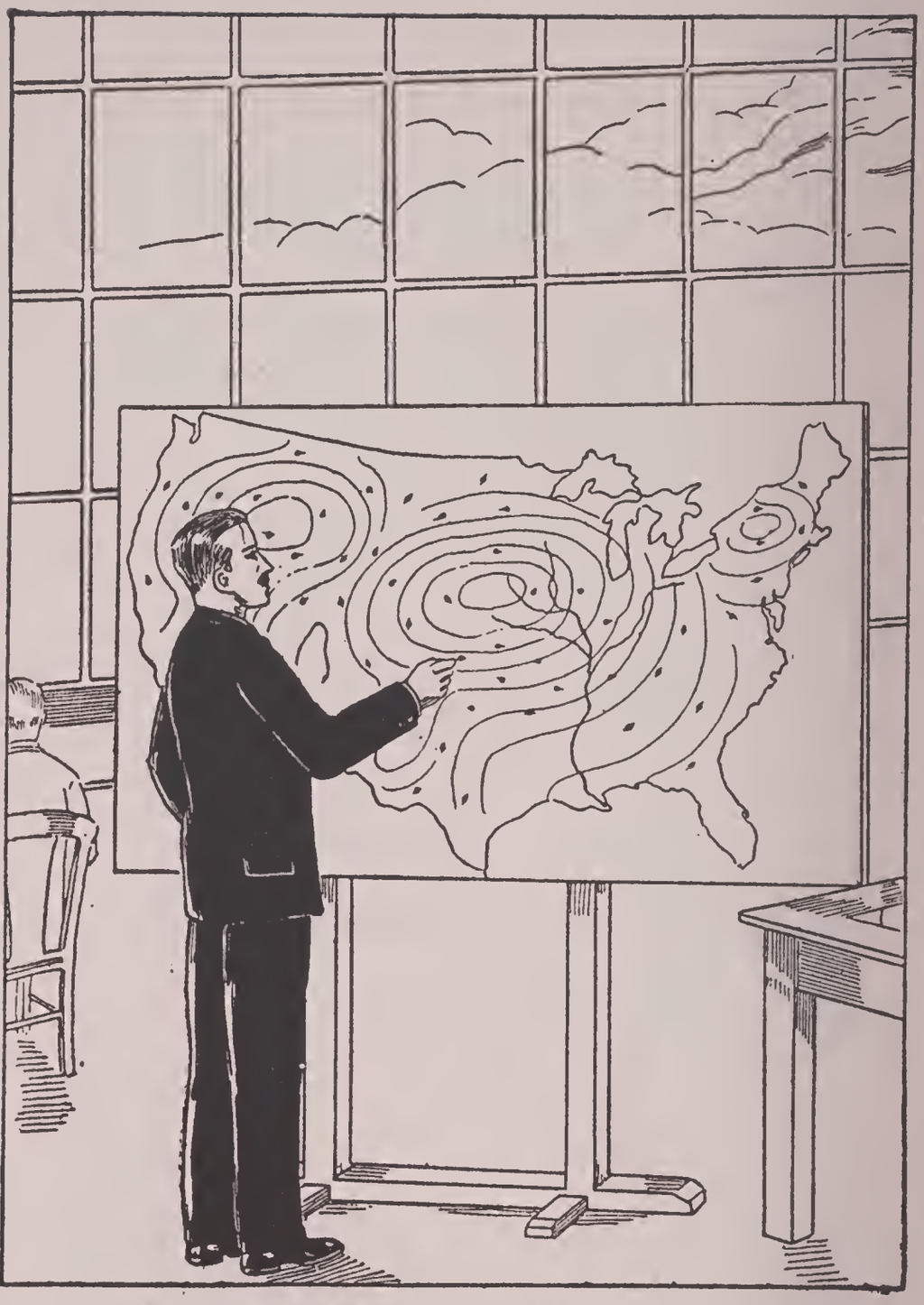
CHICAGO

Publishers' Note

This book presents in popular form the present state of science. It has been reviewed by a specialist in this field of knowledge. An excerpt from his review follows:

> *"I am very pleasantly impressed by this Story of the Weather. The author tells simply and accurately her interesting tale of the world's moods."*

Signed: GRIFFITH TAYLOR
Professor of Geography
The University of Chicago



Weather men make maps of the whole country to show the direction of the winds

THE WORLD'S MOODS

By

MARYANNA HEILE

Drawings by

JEROME GRAHAM

THOMAS S. ROCKWELL COMPANY
CHICAGO
1930

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Chapter I

THE AIR AROUND THE WORLD

AIR is a colorless ocean of gas that covers the earth. It extends, though very thin, at least two hundred miles above the earth. The gas that makes up air is really two gases, oxygen and nitrogen. Oxygen is a gas that makes things burn, and it is so active that it would burn up people if they breathed it in by itself. But it is mixed with nitrogen, which is a gas that keeps the oxygen from doing us harm.

What is air?

These gases are both clear, so that if no smoke or dust or steam were mixed with the air people could see for miles and miles. But near the ground there is always a lot of dirt and water mixed with the air, especially in the big cities. Everybody breathes in a great deal of this dusty, smoky air. If they breathe through their noses the little strainers up in their noses take

the dirt out, but if they breathe through their mouths the dirt goes right into their lungs and is very bad for them. These little strainers in their noses make the air warm in cold weather, so that it doesn't hurt the lungs.

When the air keeps still nobody pays any attention to it, but when it moves around making the trees toss about and the dust blow in people's eyes, and the window shades flap, then it is wind, and everybody talks about it. When the wind gets very strong, so that it makes tornadoes and hurricanes, and blizzards, then it does a great deal of damage. The air weighs a great many pounds on every square inch of the earth, but while people keep air in their lungs they don't feel the weight on the outside.

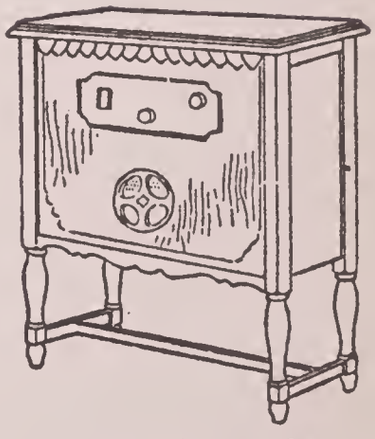
What use is the air except to breathe?

Everybody in the world keeps on breathing air—about sixteen breaths every minute—as long as they are alive. But the air is good for other things. Waves travel on it just the same way that waves go on water in a lake or river. When a stone is dropped into water it makes

ripples that get wider and wider and finally die out some distance away from the stone. The air has sound waves just like that. When a sound is made in the air, waves go away from the sound and die out some distance away. Near to the noise the waves are big and the sound is loud; farther away the waves are small and the sound is faint; far away it cannot be heard at all.

The air can carry several kinds of waves at the same time. The sun is very hot, so hot that although it is millions of miles away it can send heat to the earth. The heat travels through space on heat waves. When the earth gets warm it sends out heat waves, too, so that on a hot summer day people get heat from two directions, up from the earth and down from the sun. Smell waves travel on the air as the others do, but for shorter distances.

Not long ago a wise man in Italy named Mr. Marconi discovered that he could send out another kind of waves by using electricity. Those waves were a kind of sound waves. They



A radio catches certain waves

could be caught by a little machine that is called a radio. Now everyone can hear music and speaking coming through the air.

The clouds float around in the air until they are ready to come down in rain. Balloons and airplanes travel through the air. Trees and grass and plants of all kinds get the gas called nitrogen from the ground and make it into food for us to eat. The corn and wheat that people eat have nitrogen in them that the plant got out of the earth and stored up in the grains.

How far up does the air go?

Not long ago an army aviator went up in a balloon to see how far he could go above the earth. He got up eight miles. Up there the air was so thin that he could not breathe and was just able to get his balloon started down before he fainted. It was so cold up there that he froze his face. Little balloons without anybody in them have gone up as far as twenty-five miles above the earth.

The higher up a person goes above the earth, the thinner the air gets, so that after a while people cannot breathe and must come down.

It gets colder and colder the higher up it is until it is more than one hundred degrees below zero. The sun's rays seem to go through the upper air without making it any warmer. The air is in layers one on top of the other, each one thinner than the last. The one that is around the earth is the thickest.

Why is the sky blue?

The sky isn't really blue at all; it just looks blue. Aviators who have gone up five or six miles into the sky say that it is black. There is no color there at all; it just looks blue to us.

The reason for the blue color that everyone sees is this: The sun's rays are made up of a mixture of all the colors there are: violet, blue, green, yellow, orange, red. When these colors are all mixed together people's eyes see white. When there is no sun at night and no colors at all, people see black. It means that there are no light waves around. Black isn't really a color; it is just no color at all.

But these colors in the sun's rays are each one a little wave in the ether. The red waves are the longest, the orange ones are next longest,

then the yellow and green and blue ones, and the violet waves are the shortest of all.

When a wave in the lake strikes the shore it breaks all up into bits of water and foam. When a ray of sunlight strikes something thicker than air, like glass or water, all the little color waves break up, so that instead of white light there are colors. Sometimes the sun shining through a goldfish bowl will break up into colors; sometimes a piece of three-cornered glass will do it; sometimes the sun shining through the spray from a grass sprinkler will make little rainbows.

A rainbow in a sprinkler

The air is never clean. It is always full of smoke and grains of dust and tiny drops of water. When the sun shines through all those little particles they turn aside the shortest waves. The shortest waves are the blue ones. When so many of them have been taken out of the sunshine and turned toward us the sky looks blue to persons living on the ground.

If the day is very clear, perhaps after a rain has washed most of the dust out of the sky, the

sunlight will look white. But on a day when there is much dust and dirt in the air the sunlight slanting across the fields and houses near evening looks as yellow as gold. That is because the bits of dirt in the air have taken out a great many of the blue waves out of the sunlight. When the blue waves are taken out the yellow ones show up more. That is why the sunlight looks yellow. It looks yellower in the late afternoon because it has farther to go when the sun is over in the west, and so has to go through more dust, so that more of the blue waves are taken out.

Why does sunlight look yellow?

Sometimes when the sun is ready to go down, so many of the blue waves have been taken out of the sunlight that only the orange, red, green, and violet waves, are left. Then these colors show in the western sky and people see a fine sunset. Sometimes conditions are so that there is very little color to be seen in the sunset. Then we know the light is not being interfered with.

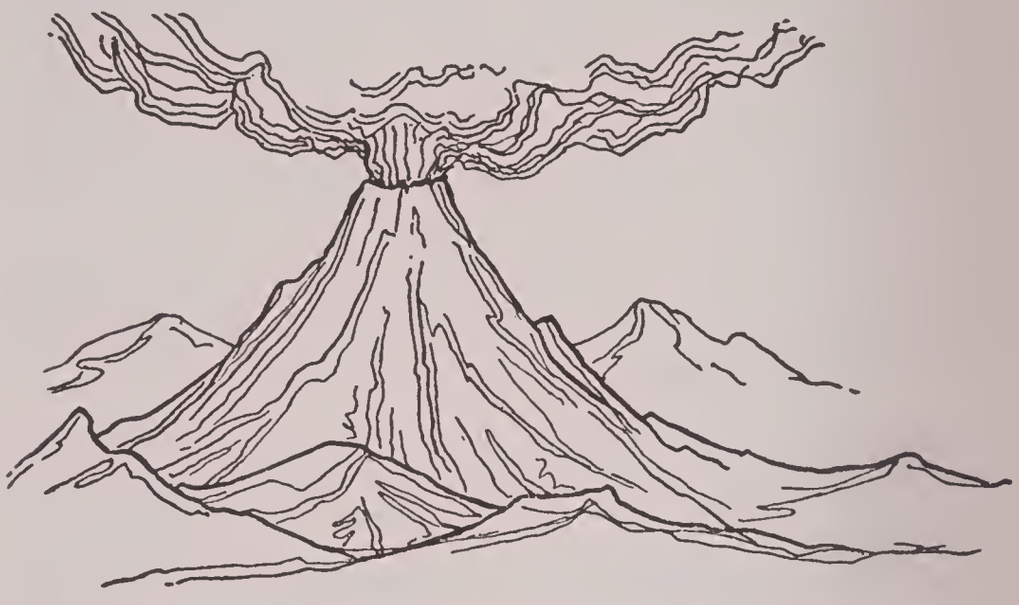
What makes the colors in the sunset?

If there are clouds near the sun when it sets the red rays go up and strike the clouds and are

A sunset has lovely colors

reflected back in pink and lavender. Fog and smoke and dust will make the sunsets even more beautiful, for there are then more particles in the air to break up the white light of the sun.

When great volcanos have erupted, throwing into the air a great lot of fine dust, the sunsets



Volcanoes throw up clouds of dust from inside the earth to make trouble in the air

are very beautiful. Some great eruptions of volcanos have made so much dust that some of it floated all over the world. A hundred and fifty years ago a great volcano in Iceland opened and blew into the air much dust as fine as

powder. It was really rock ground up fine down in the volcano. For six months this dust made a thin smoke all over Europe, frightening people everywhere. Since people didn't know what caused it they thought that the end of the world was coming.

The sun looked red through the dust, which scared them all the more. They gave away their farms and dug their graves and got all ready to die, but the dust settled down finally and the rains washed it away, and the people forgot how frightened they had been and went back to their work.

Where do the rainbows come from?

When it rains and the sun is shining, a lovely half circle of colors comes in the sky just opposite the sun. That is a rainbow. It is always in the sky across from the sun; it comes only when the sun shines through the rain. Usually on the top of the bow is red, then yellow, then green, then blue, and on the bottom, violet. Sometimes the colors are in the opposite order and sometimes some of them are missing.

The old Greek people have a story that the

rainbow was placed in the sky by Zeus, the king of the gods, as a pathway for Iris, who was the messenger of the gods, when she carried messages to the other gods. They thought that the bow of colors reached from one side of Heaven to the other. In other stories the rainbow is the scarf of many colors that Iris wore about her shoulders. She ran so fast that the scarf was blown out across the sky.

The Indians in America had a pretty story that the rainbow was made up of the souls of the dead flowers. In Longfellow's poem, "Hiawatha," the little Indian boy asked his grandmother what the rainbow was.

"And the good Nokomis answered:
'Tis the Heaven of flowers you see there;
All the wild flowers of the forest,
All the lilies of the prairie,
When on earth they fade and perish,
Blossom in that heaven above us."

But what really happens when the sun shines while it is raining is that the beams of sunlight passing through the millions of raindrops are

Nokomis explained to Hiawatha what made the earth and sky and the colors of the rainbow

broken up into the six colors. The water in the raindrops is thicker than the air. First it breaks off the red color waves of the sunlight, then the orange, then the yellow, then the green, then the blue, then the violet.

If two showers come one right after the other, sometimes there are two rainbows, one below the other. People used to say that there was a pot of gold at the foot of the rainbow, and many people went out to look for it, but no one ever found it.

Once a man had a field that he was too lazy to plow. One day a rainbow ended in this field. His neighbors told the lazy man that if he would dig in the ground he would find the pot of gold. So he went out and dug all over the field, but he did not find the gold. Since he had the field all plowed up he planted some wheat and grew a fine crop, which he sold for a great deal of money. The moral of the story is that work is better than gold.

Chapter II

NIGHT AND DAY

ALL of the light on the earth comes from the sun. The sun stands still up in the sky, but the earth doesn't stand still at all. It makes two different kinds of movements. First, it turns all the way around, like a top spinning, every day. Second, it makes a trip all the way around the sun once a year. That is, the earth turns itself, so that we go around in a little circle every day and night. It does that three hundred and sixty-five times in a year, but while it is turning in this little circle it makes one big circle around the sun.

Why does it get dark at night?

When the earth is making the little circle every day, one-half of the world is turned toward the sun and one-half of it away. When any part of the earth is turned away from the sun it is dark there and people say that it is night.

The half of the earth that is turned to the sun gets light, and they say that it is day.

The first thing that people thought about was the sun. It gave them heat and light, and when it was dark they were afraid. The first people on the earth worshipped the sun as a god. They built temples to the sun and burned sacrifices on the altars to make him kind to them.

The Indians had a story that a brave young warrior named Wabun brought the morning. He chased the dark away by shooting at it with silver arrows. They thought that it was the crimson paint on his cheeks that made the streaks of red in the eastern sky in the morning.

The Greeks were for a time worshippers of the sun god, whom they called Apollo. He drove the chariot of the sun across the skies every day. Four strong horses were harnessed to the chariot. It was made of gold and silver, set all about with diamonds. When the horses were harnessed Dawn threw open the gates of the east and Apollo drove the chariot in which was the flaming sun, up a steep pathway to the

top of the sky and then down to the west, where Tethys, the goddess of the sea, was waiting for him. She carried Apollo and his sun chariot

Apollo drove the chariot of the sun across the sky between dawn and dark every day

in a boat back to the east to be ready for the next day's journey.

Why doesn't it get dark all at once?

In most countries there is a time after the sun goes down that people call twilight, or half light. This light gets dimmer and dimmer until, after half an hour or so, it is really dark.

The reason that it does not get dark all at once when the sun goes down in the west is that the sun's rays travel in waves. These waves do not always go in a straight line.

Some of them come up over the curve of the earth in the west and make light even after the sun is gone. As the sun gets farther and farther down, fewer light waves can reach us over the edge of the world. Finally they do not come at all and it is really dark.

It never gets entirely dark on the earth. There are always a few light waves getting around to the side that has no sun. The stars give a little bit of light. Some animals, like the owls and cats, can see in the dark. Their eyes are made to use the tiny bits of light that are on the earth, even after it seems very dark to people with common eyes.

What makes moonlight?

The moon travels around the earth in just the same way that the earth travels around the sun. The moon does not turn around like a top the way the earth does. It only shows one side of itself to the earth.

There isn't any air around the moon, and it is a cold land without any people or plants or animals. It is just rocks and mountains and deep valleys of stone. Because it hasn't any

air, or trees or grass, the moon is like a big round looking glass that reflects the light of the sun. When the moon shines on the earth with a strong white light, it is just the light of the sun being reflected back from the moon onto the earth, in just the same way that a lamp is reflected in a mirror hanging on the wall.

Moonlight is sometimes quite bright, but it is never warm. The light waves from the sun can strike the moon and come back to the earth, but the heat waves cannot. Some of the color waves that are in daylight are not in moonlight, so that colors like red, green and purple don't show up very well under the moon.

Artemis, the goddess of the moon, was the twin sister of Apollo. She was the goddess of the hunt, but she helped to protect the animals of the wood, especially the deer. Her brother took care of the day and the sun, but she was queen of the night and the moon.

The goddess of the moon

The moon goes around the earth once a month. Part of that time the shadow of the earth gets in between the sun and the moon, so

that only part of the moon shows. One reason that we know the earth is round is that the shadow of the earth on the moon is always round. Once every month for two or three days the shadow of the earth does not come near the moon and then people say that it is full. It gives much light then.

What makes the days longer in the summer than in winter?

The earth goes around every day just like a top spinning, but a top stands straight up while it whirls around. The earth turns a little bit, first toward the sun and then away from the sun. The north pole is up on top of the world. If the earth just went round and round the north pole would never have any light. All the light and heat would strike the center of the earth, down around South America. But the earth moves for six months so that the north pole is turned toward the sun for that time. Then it turns back again and for six months the people up near the north pole have a long night, while the people down near the south pole have a day that lasts six months.

When the earth turns so that the north is

toward the sun we have longer days and shorter nights and we call it summer. When the south pole is turned toward the sun our part of the earth is farther away from it and the days are shorter and the nights longer, and we call it winter. The axis about which the earth turns always points to the Pole Star—called Polaris.

Up in the Arctic the weather is so cold that nothing can grow for about nine months of the year. Most of the time the ground is all covered with snow and ice. No trees can grow there, so that the people have learned to build their houses out of blocks of ice. They make them round like half of a ball. If the roofs were flat the weight of the snow might cave them in.

Inside of the house is a bench all around the wall where the family sit to work and use for a bed. In the center of the floor is a hole for the fire. Often the house is very smoky, but if it is warm the Eskimo does not care. To help keep out the cold, the door outside is at the end of a long passageway which is just high enough for a person to crawl through. The Eskimos

use dogs to pull their sleds, because horses could not live in the cold. The dogs sleep in the passage at night.

The Eskimos live on seal fat, which we call blubber. It has a fishy taste and is very oily and they eat it without cooking, but it keeps them warm through the long winter. They sometimes have reindeer meat. The reindeer live in very cold countries by eating the moss that is under the snow.

Although there is no sun for six months in the far north, it is not very dark because the stars give some light and the Aurora Borealis that shines like a great rainbow in the northern sky all winter long makes pink and purple and blue lights on the snow.

Chapter III

HEAT AND COLD

WHEN the earth turns toward the sun around the imaginary line called its axis, during our springtime and summer there is more heat here because we get the sun's rays more nearly straight. They are hotter because they do not have quite so far to go and they do not lose so much heat as they come through the air. The sun is very hot at the equator, which is an imaginary line drawn exactly half way between the north and south pole. It is not so hot further away because the rays must travel in a slanting direction through the air to reach the earth and some of the heat is lost.

Why is it hot in the summer time?

On June twenty-first of each year the earth has turned so that the north pole is looking toward the sun. Then the days in the United States and Canada are about fifteen hours long.

On December twenty-first the north pole is turned as far away from the sun as possible, and on that day we see the sun for only about nine hours.

During the long days the ground gets hot and does not cool off very much during the short nights. That helps to keep the earth warm in the summer time. Of course, while the people in North America are having summer because the earth has turned on its axis toward the sun, the people in South America are having winter because their country is turned away from the sun.

All the seasons of the year are caused by this turning of the earth. If the earth stood up straight all of the time and did not turn toward the sun and away from it, we would have just one kind of weather all the time. Since North America is a long way north of the equator, where the sun would be shining if the earth did not turn, we would have fairly cold weather, about the kind of weather that we have now in March and September. Not many of the trees

and plants that we have would grow very well if it were that cold all the time.

Why is it cold in the winter time?

In December, January, and February, the earth is turned away from the sun in this part of the world. It is turned so far that up where the Eskimos live they do not see the sun at all. In the United States we get some of the sun's rays, but they come to us so slantingly that they have lost much of their heat and do not give us very much. Then we have ice and snow and cold weather. The great amount of ice and snow in the north help to keep it cold there after we have spring, but often the summers in Alaska are warm and pleasant.

The countries that are near the north pole and the south pole never do get very much heat from the sun even when they are turned toward it. They are too near the top and bottom of the earth and the rays of the sun strike them too slantingly. Up in Canada the summers are short and only a few kinds of grains that will grow and get ripe in three or four months can be raised. In the northern parts of Russia they

have very short summers, too, and can only raise certain things.

At the earth's equator the sun shines very hot all the time and, where there is rain enough, the trees and other plants grow very large and tall. The people there do not have to worry much about clothes to wear because it is so hot, and they do not work very hard to grow things to eat because in the great heat plants grow very fast. They can often just go out and pick a dinner off a tree. Cocoanuts, bananas, breadfruit, and oranges, grow without any help from the people who eat them. It is so warm that they do not have to worry about houses either.

As the summer goes on, the earth slowly turns back so that the equator is directly under the sun, and the weather gradually gets colder. We call that time fall. Then comes the cold winter. After the winter the earth turns again and we have warmer weather, or spring. Every year the same thing happens in the same way.

The old Romans had a goddess that they

called Ceres, who, they thought, made the seasons come and go. They thought that for six months she was mourning for her daughter who had been stolen away from her. During that time she was sad and did not let anything grow upon the earth. Then for six months her daughter came back to her and she was happy and made the trees bloom and the crops grow.

Why are some summer days cold?

The air around the earth is in motion all of the time. When it is warm it gets lighter and then it rises and cold air comes in to take its place. There are some high mountains where the sun never melts. The air from these mountains gets very cold and flows down on the plains, making them cold.

Sometimes wind blowing over the ocean gets very cold before it blows on the land. Clouds get between the earth and the sun and keep the sun's rays from striking it, so that the earth gets cold even in the summer time. Rain may fall and use up the heat that is near the ground to dry up the water. There are so many things that can happen to change the weather that it

is seldom the same for more than a day at a time. We ought to be glad this is so, for people would soon become tired of the same weather day after day.

The snow is cold, but it turns the country into a clean, white fairyland

Chapter IV

WATER IN THE AIR

WHEN a kettle boils on the stove, steam comes from it. The steam looks white near the kettle, but a little way from the fire it disappears. When a pan of water is set on the radiator for a few days the water vanishes. When it rains the sidewalks are wet for a time, but before long they are all dry again. Where does the water go?

What makes water dry up?

The water evaporates. That is, it dries up. It turns into tiny drops like steam, so little that they cannot be seen, and they float off in the air. The air always has some of this moisture. Sometimes it is called vapor. Even if the land is very dry, there is water in the air, because the rivers and lakes and oceans give up some of their water to it. The moisture is carried by the winds even over deserts.

When a tin can of cold water is taken into a warm room, drops of water gather on the outside of it. Since the water could not climb out of the tin can it must be the vapor in the air settling there. If the tin can was in a desert place where there had been no rain for months the water drops would form on the outside just the same. It might be water evaporated from an ocean hundreds of miles away blown there by the winds.

Heat makes the water on the earth dry up faster. When the sun is shining the rain is gone much quicker than on a cloudy day. The wind helps, too, because it blows away the tiny drops and lets others form where the water is lying.

Where does the rain come from?

These tiny bits of water in the air are too small to see by themselves, but they get together around the grains of dust in the air; we say that they condense, which means to come closer. These tiny drops are not big enough to be rain; they are more like mist.

The air they are in is near the earth and is warm. It rises up and spreads out. As it

spreads it gets cooler. When a quart of air spreads out into two quarts it gets colder because it has only heat for one quart to give to two quarts. As they get cooler the tiny droplets of moisture around the little grains of dust get together in one great mass and make a cloud.

The cloud is heavier than the rest of the air and would sink to the ground if the warm air rising from the ground did not keep pushing it up. The winds blow it around. It gets bigger and bigger as more droplets join it. Then the warm air pushes it up so far that it gets cold. The cold makes more vapor condense on the little drops. They get so large and heavy that they cannot stay up in the air and so they fall down to the earth and the people on the earth put up their umbrellas because it is raining. The first drops are the largest because they have picked up some of the smaller drops on the long way down.

Do all clouds make rain?

Some clouds are not carried up by the warm air rising. They slowly sink down to the ground again. When they get near the ground

the air is so warm that they change back into vapor again and go off into the air. A cloud may be formed in one part of the country and blown far away by the wind so that the rain does not fall from it until it is hundreds of miles away from the place it started.

Often a great deal of rain falls on one side of a mountain range while almost none at all falls on the other side. The mountains may have too much rain on one slope and a desert on the other. The reason for this is that the wind blows from one direction. It brings the clouds to the mountains, but they cannot get over the tops without going high up in the air. As they go up they get cold and the drops of moisture go together until they are so heavy that they fall in rain before the cloud can get over the mountain. When the wind gets over to the other side it does not have any clouds; they have all turned into rain.

That is what happens out in California along the Coast Range of mountains and in India along the Himalaya Mountains.

Some countries have a rainy season and a dry season. All of the rain falls during a certain two or three or four months. The reason for that is that in those countries the wind blows for those months from a direction where there are clouds. They bring the clouds and the rain falls. Then the winds change to some other direction and no rain falls for many months.

Do clouds have different names?

All clouds do not look alike. The men who foretell the weather know by looking at a cloud if it is a raincloud or not. Some clouds look white and feathery; others look grey because the sun is shining behind them. Storm clouds look black and purple.

Cirrus clouds are curly

The clouds highest up in the air, sometimes eight or ten miles up are called the cirrus clouds. The word cirrus means curl. They look like great white curls of feather. The winds in the upper air bend and curl them about. They are long and slender and often are frozen clouds because the cold is so sharp up that high.

On bright summer days there are many cumulus clouds. They are like piles of soap

Cumulus clouds are like soapsuds

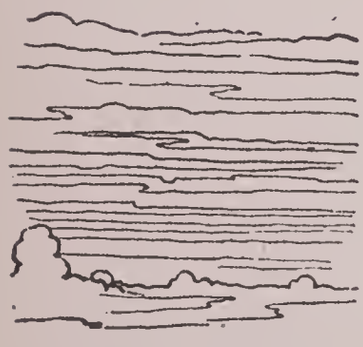
suds, or woolly heaps. They are white and very pretty against the blue sky and the sunshine. They are often five miles up in the air and are carried about by the high winds. At the top of a mountain travelers can look down on the top of cumulus clouds that are resting along the slope. The cumulus clouds often get very large and on hot days cause thunder storms.

The clouds lowest to the earth are called stratus clouds. The name means layer or sheet. When a great deal of air rises from the ground and gets cool without being moved about by winds, this kind of a cloud is formed.

Where do fogs come from?

Fog is just air that is filled with water which lies close to the earth. It is oftenest seen over a lake or an ocean. When fog comes over the land it usually is called mist, but fog and mist are the same thing.

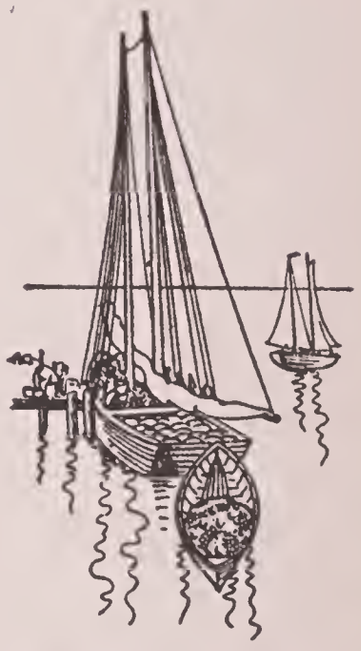
Fogs are like clouds close to the ground. Water from the river or ocean, or just from the wet earth, goes into the air in tiny drops. These drops collect as the night gets cool, and if there is no wind to blow them away, they stay on top



Stratus clouds are in layers

of the water. A fog is not like a cloud in one way. The vapor in a cloud goes together and makes big drops which fall in rain when they get cold. A fog, for some reason, never does collect and make rain.

If a wind comes along, it blows the fog or mist away. If the sun comes out hot the tiny drops that are big enough to see divide into vapor again and disappear. The fishermen along the seashore do not dare to go out on the water when there is a bad fog because they cannot see their way and they might get run into and wrecked. So they sit along the shore and hope that the sun will come out hot and "burn the fog up."



The boats stay in harbor

Up along the shores of Newfoundland where great fleets of boats go to fish every year there are very heavy fogs. When they come the men cannot fish and they stay in the boats and sound the fog horns every few seconds. Often the boats run into each other or into the icebergs that float around in the water.

England is a small country entirely sur-

rounded by water, and there is much moisture in the air all the time. When a cool wind blows over the island it very often makes bad fogs that last for two or three days. They are so smoky that people cannot find their way around the streets. The lights do not do much good in such a fog, and many persons do not get to their homes until it goes away.

Can fog be driven away?

For a long time men have been trying to find a way to get rid of fogs. They have discovered that the tiny drops of water in the fog have a certain kind of electricity in them. If the other kind of electricity is put in sand and the sand is dropped into the fog it will go away. But it is too expensive to put the electricity into the sand and to hire an airplane to go up and drop it into the fog.

Fogs over the airports make it very hard for the aviators to land because they cannot see. Great ships do not dare come into a harbor when there is a fog. If some way could be found to drive it away without waiting for the wind and the sun to scatter it, much time and money could

be saved. Fog has some use, however. There are places in the world where it never rains, and yet plants and trees grow because the fogs bring them all the moisture that they need.

What makes the dew?

For a long time people thought that dew fell from the sky during the night just like rain. But about one hundred years ago it was discovered that dew did not fall at all; it collected on the leaves and roofs out of the air. The air has some water vapor all the time. If this vapor strikes anything cold, it collects on the cold object, just as the water gathered on the outside of the water pitcher.

When the sun has gone down at night the earth cools off very quickly. The leaves of trees and grass are thin and they lose their warmth in a very little while. When the moisture in the air is blown against the cool leaf by the little breezes near the ground it collects on them and if a person goes out to walk in the grass about two hours after the sun has gone down he will find that his feet are wet with the evening dew.

If the wind blows too hard the little drops of vapor are tossed about so fast that they cannot stop on the leaves, so that there is no dew on a windy night. If the sky is covered with clouds the dew will not form because the clouds act like a big blanket over the earth. They keep the heat from leaving the earth. The leaves keep their heat and the vapor in the air does not find a cold place to gather on.

Sometimes there is dew on the under side of leaves of cabbages and grass blades that are near the ground, even if there is no dew on the tops. The moisture from the ground—there is always some water in the ground—rises when the earth cools at night and some of it strikes the cool under side of the plants that are close to the ground and makes dew there. So that dew doesn't ever really fall, but it does sometimes rise up from the ground.

In the morning the wind and sun dry up the dew again very quickly. That is, the drops of dew turn into vapor again in the air. The same vapor may gather again the next night on the

same plant if it is not blown away by the wind.

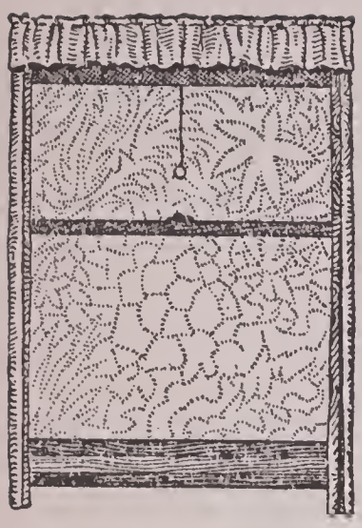
Frost is dew that has frozen as it gathered. On cold nights the vapor collects just as it does for dew, but the things it gathers on are so cold that it freezes. In the morning people see a thin white coat over everything, as if there had been a little snow storm.

What is frost?

The thick frost that gathers on the ground is sometimes called hoar-frost. It is the moisture that is rising from the ground that has frozen. Frosts kill many plants and leaves that they freeze on. If the weather man says that there will be a frost everyone tries to cover the flower beds to keep the frost from collecting on the plants. The men who have orchards in bloom in the spring when it gets cold enough to freeze the blossoms sometimes build fires between the trees to keep the air warm so that the frost will not come on them and kill the fruit.

There is vapor in the air even inside of the house. In cold weather the air near the windows is colder than anywhere else because some of the cold from outside gets through the glass.

Why does frost make pictures on the window panes?



Frost pictures on the window

The moisture in the air near the window wants to collect, so it collects on the nearest cold object, which is the window pane. The little drops of vapor, when they freeze, try to make patterns with six corners, but other drops freeze on top of them and bits of dirt and grease on the glass get in the way. All that the vapor drops can do is to make pretty pictures of ferns and trees and flowers on the glass.

Long ago there was no black dirt or sand on the earth. It was all hard rock. Nothing could grow because there was no place for the plants to put their roots.

What good is frost?

But the rains came and washed tiny pieces off the rocks. The winds blew and drove the grains of sand against them. The frosts froze the water in the cracks and split them; and after a long time dirt was made. Seeds were brought by the wind and washed down by the rivers and trees and grass grew in the piles of ground up rock. When they died they helped to make more soil. Rivers, winds, rains, and frosts, all help to make more dirt for plants to grow in.

The frost is still at work every winter breaking up the clods in the fields and the stones along the rivers. In that way the frost pays the farmer for killing his crops too early in the fall sometimes, by making new earth for him.

Why is the snow white?

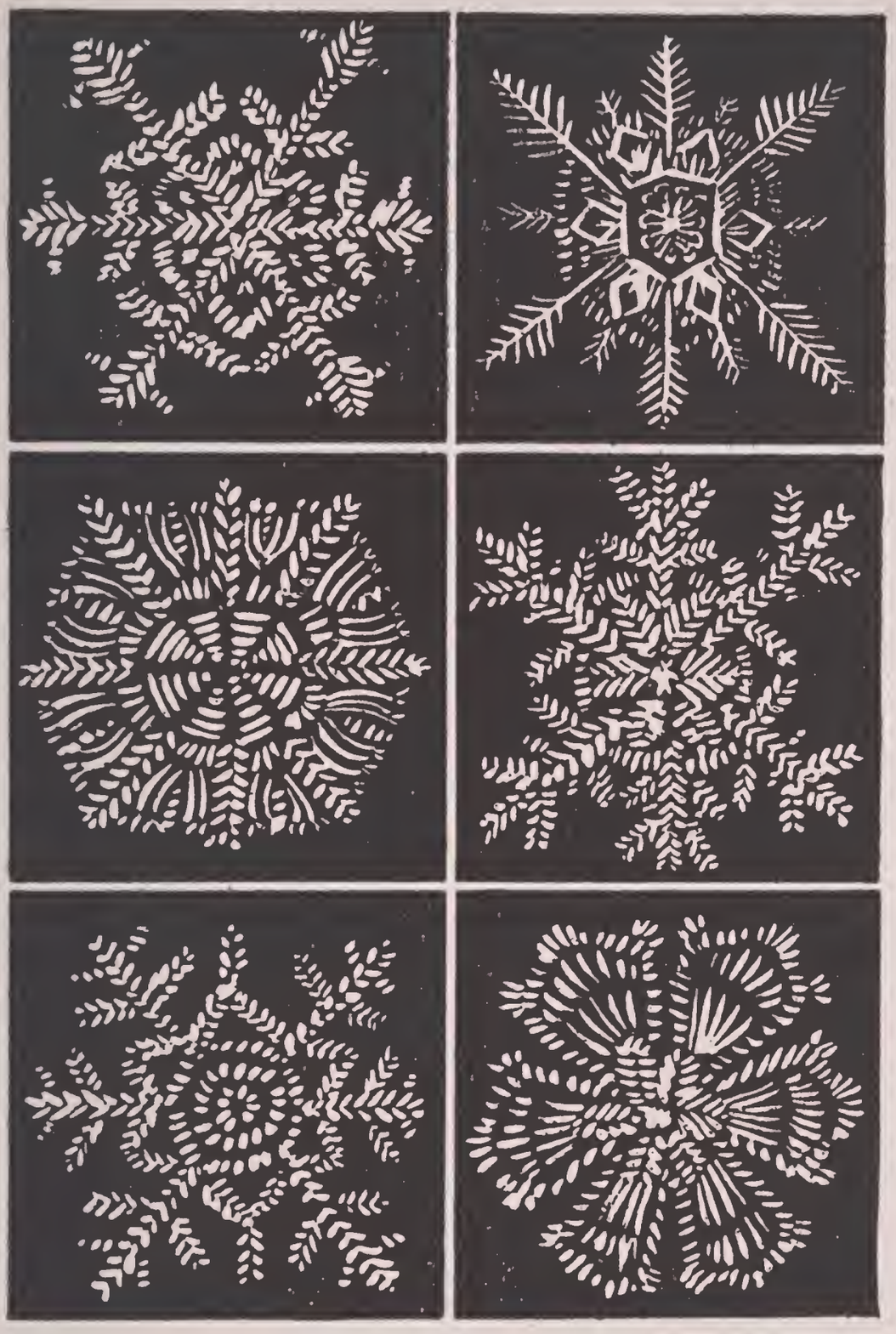
Snow is not frozen rain. It is frozen cloud. It comes from clouds that have been taken by the winds up two or three miles into the air where it is very cold. Here the little drops of vapor do not make rain drops because they are frozen before they can get together. The tiny vapor drops meet each other and as they freeze make a snowflake that has six points. When a snowflake lands on a black coat sleeve it often does not have all of its points because some of them have been broken off in coming down two miles through the air. They all start out from the cloud with six points.

The snowflake is really very thin ice, and if we could look through it, we would find that it was clear like a piece of ice. It looks white because the light shines on it from so many sides that our eyes see nothing but the reflection

of the white light. Every snowflake has six sides, but no two flakes are ever alike. A man who has been studying snow for ten years has taken pictures of more than five thousand snowflakes, and they are all different.

What good is snow?

The snow is light and is easily blown by the wind and piled up in drifts. When this happens the roads are blocked and people cannot get to their work, children cannot get to school, street cars do not run, and everyone is very cross until the roads and streets are shoveled out again. Sometimes the snow comes from a cloud that is very high up in the sky where it is very cold and the flakes are small. If a strong wind comes while these tiny flakes are falling we have a blizzard. In the western states and in Canada these blizzards are so bad the air is filled with the little flakes until no one can see even two feet ahead. People who get caught in a blizzard often die because they cannot find their way to shelter. Men are afraid to go from the house to the barn to feed the cattle, for fear of getting lost. Often they build a covered passage to the



Snowflakes freeze in shapes like fine white feathers,
always with six points or six sides

barn to use in case of bad snow storms. Many times when one of these storms came up the children in the little country schoolhouses had to stay all night and sometimes for three of four days at the school until it stopped snowing, because they could not get home.

Hunters can follow the tracks of the animals in the snow. The Indians made snowshoes of small branches and deerskin. They looked like a tennis raquet, but with them on his feet an Indian could travel on the tops of the snowdrifts. In many places people use skis, long narrow strips of wood, one on each foot, to travel very swiftly over the snow.

Snow is very beautiful when it is new and white. If a wind is blowing while it is falling it makes queer and lovely shapes around the trees and bushes. An American poet, Mr. Whittier, has written a poem about a bad snow storm that he saw when he was a boy.

"Unwarmed by any sunset light
The grey day darkened into night,
A night made hoary with the swarm

And whirldance of the blinding storm,
As, zigzag, wavering to and fro,
Crossed and recrossed the winged snow:
And ere the early bedtime came
The white drifts piled the window frame,
And through the glass the clothesline posts
Looked like tall and sheeted ghosts."

Although the snow does so much damage it is useful as well. The roots of plants would be frozen during the cold winter if the snow did not cover them and keep some of the bitter cold out. When the snow melts in the spring the water makes the ground wet and helps the crops to start growing. It takes ten or twelve inches of snow to make one inch of water.

What makes the hail?

Hail is rain that has frozen before it fell. It is made high up in the air where it is cold. One of the little water drops around a grain of dust freezes in the cold air and starts to fall. It is so cold that other drops of moisture gather on it as it goes through the cloud. Before it gets through the clouds a strong upward current of air strikes it and takes it back higher again. There it is frozen again and gathers some more

water and snow around it. This may happen three or four times until the hail stone is so large that it falls.

The hailstone is made up of a center of ice, then many layers of ice and snow frozen around it when it had gone through the clouds up and down. Hail always falls during a thunder storm and usually after a very hot day when there has been a great deal of warm air rising from the earth. The stones may be very small, or as big as marbles. Some people claim that they have seen them as big as baseballs.

A bad hail storm may do a great deal of damage. The stones are driven by a strong wind very often, which throws them through glass windows, beats down the crops in the fields, strips the leaves off the trees, and even kills small animals. There is no way that anyone knows to stop hail from falling on the earth.

What is sleet?

What most people call sleet is rain falling on a cold day so that it freezes as soon as it touches the ground. It freezes on the trees, on the telephone wires and on the sidewalks. It may keep

on raining and freezing until the ice is an inch thick. Then people must put sand and ashes on the walks to keep from slipping, and the great weight of the ice on the trees breaks off branches. The telephone wires break and the linemen must work hard to repair them.

Real sleet is snow that has struck a warm layer of air and has partly melted before it reaches the ground, or it is tiny drops of vapor that have frozen and are falling without becoming snowflakes.

How do people skate on ice?

When the first ice freezes on the lakes and ponds and rivers, people get out their skates and sharpen them ready to go skating. It is the best of all winter exercises. People do not go out of doors enough in the cold days. Skating makes the ankles strong and keeps the rest of the body straight and healthy.

Many people do not know that skates do not really slide on ice, but on water. When the sharp edge of the skate strikes the ice and slides along it, the scraping makes a little heat. The heat is enough to melt a tiny bit of the ice.

The skate slides along on this little sheet of water, just as if it were oil spread on the top of the ice. When the skate has gone on, the little film of water freezes again at once.

It does not often get cold enough in England for ice to freeze sufficiently hard to skate on. The people there often go to Switzerland for the winter sports. It is cold enough there, high up in the mountains, so that they can skate and go on ski trips, and slide on the great toboggan slides. The sun is bright there, because it is high up and the air is clear.

Chapter V

THE WIND

ALMOST as soon as men began to think about the sun they must have noticed the winds. They made up stories about the winds, as they did about everything else that they did not understand. The Indians said that Wabun, the warrior whose silver arrows drove away the night, was given the east wind by his father, who was king of the winds of heaven. Shawondassee was given the south wind, Kabibonokka, who lived in the land of ice and snow, was given the cruel north wind. Mudjekeewis, the father, kept the west wind himself.

Where does the wind come from?

In the winter the north wind came and stayed in the wigwams of the Indians, but a brave man wrestled with him and drove him north again in the spring and the lazy south wind sent the birds and flowers north.

The Greeks had a story about the winds. They called the king of the winds Aeolus. He lived on an island in the ocean. The four winds he kept shut up in a cave on the island, and he only let them out when he wanted to, or when one of the gods wanted a wind. The west wind was a gentle and kind wind called Zephyrus. The north wind was called Boreas. He was rough and rude.

We do not make up stories about the winds any more because men have found out what causes them. They are started blowing by the sun, which seems to be the force that starts almost all the weather.

Warm air does not weigh as much as cold air. When the air in one place gets warm it rises. Other air must take its place, so cool air moves in. Then other air has to take the place of the cool air, and so there is movement of air all over the land.

When the cool air reaches the place where the sun warmed the first lot of air, it, too, will be warmed and it will go upward, while still other

air will come to take its place. The air that goes up does not make any wind; it is the cool air coming in to take its place that we feel and call wind. When a window is opened at the top and on the bottom on a cold day the warm air goes out the top opening and cold air comes in at the bottom. Someone will say that the cold air coming in is a draught, but it is the same thing that a wind is, only it isn't so big.

If the earth were like a ball with the sun shining on the equator every day, the winds would be always the same. The sun would warm the air in the middle of the earth; it would rise and half of it go toward the north and half to the south. Then cool air would come in to the center of the earth from both north and south. All the winds would be blowing toward the equator. In North America the winds would all be toward the south and in South America all the winds would be toward the north.

But the earth does not stand still. It turns every day and that affects the winds. The mountains and the cold oceans and the lakes

and deserts change the currents of air. Cold winds come down the mountain sides; warm air sweeps up; winds turn aside to go around or over mountains; everywhere the winds are twisted into different shapes and directions.

Where does the wind go?

No one can tell just where the wind goes to. When it blows over our part of the land it keeps on going in the same direction until it gets warm enough so that it rises into the sky. There it gets cold again and comes down to take the place of some other air that has gotten warm. Usually the wind blows from a cold place to a warm one, and from a place where the weight of the air on top of it is great to a place where the weight of the air on top is not heavy enough to stop it.

Air does not seem to have any weight because people can not feel it on their hands and heads. It isn't very heavy, but there is so much of it above the earth that it does weigh a great deal. Some men who have studied the air say that it goes two hundred miles above the earth. The air does weigh about fifteen pounds on every

square inch of the surface of the earth, on every inch of the surface of every house and of every person's body. The reason that this great weight doesn't crush a house, because it amounts to many tons on even a small house, is that there is air inside the house. The air inside pushes out with just the same force that the air outside pushes down. There is a weight of one hundred and fifty pounds on a person's hand as he holds it out. But there is a weight of one hundred and fifty pounds under it pressing up, so that the person does not feel any weight at all.

It is this great weight of the air up above that makes the air on the earth move about in winds. Land gets cold and hot so easily that the winds on land change often. The mountains and rivers and lakes on the land change the direction of the winds. On the ocean the wind does not change very often because the ocean does not get hot and cold very fast. Water in great bodies like the ocean does not get warm very quickly in the summer, and there are no mountains in the ocean to turn the winds aside. The winds

on the ocean blow steadily from one direction for a long time.

What are the "trade winds"?

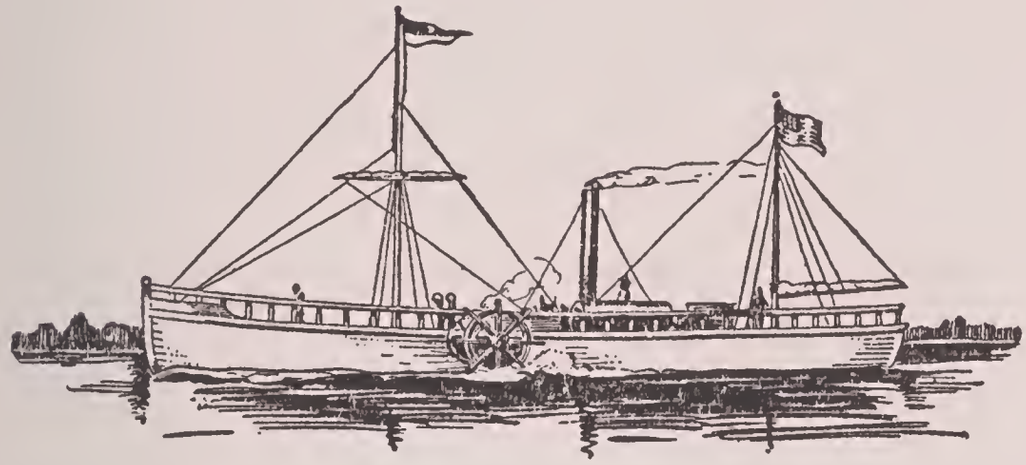
When the Pilgrims came to America three hundred years ago it took them almost three

It took the wind several months to blow the Pilgrims' ship across the ocean

months to come from England. A short time ago a ship crossed the ocean from England to America in four days. The reason that the Pilgrims came so slowly was that their ship was a sailing vessel that had to wait for the wind to drive them along. If the wind did not blow the ship had to stand and wait for another wind.

When a man named Robert Fulton made the first boat in America that was driven by a steam

engine and did not use sails everyone laughed at him. People were so used to using the winds and traveling in sail boats that they did not see how there could be any other kind.



The first steamboat was pushed through the water by a paddle wheel on the side

Now there are hardly any sail boats left on the water. The great steam boats are so much faster and safer because they do not have to wait for the wind. But three hundred years ago the sailors had to depend entirely on the winds. They learned that there was a place north of the equator where the winds always blew from the northeast. South of the equator they blew from the southeast. The men going out in ships to

trade with India or China learned to use these winds to blow them there and back. So they were called trade winds.

The sailors hated to get directly on the central zone of the earth because there are fewer winds there than elsewhere. They call it the belt of calms. There is a reason for the trade winds and for the belt of calms. The sun shines hottest on the center of the earth where the imaginary line called the equator is. The land there gets very warm and the air gets warm and rises just as warm air always does anywhere. As it goes up half of it goes to the north and half to the south. It gets cooler and starts to come down. If the earth did not move it would make winds directly from the north and from the south blowing toward the equator, but the earth is turning all the time from the west to the east, so that the winds are turned and blow from the northeast and southeast.

A boat in the calms

Because it is so very hot around the equator the winds get hot and rise before they reach it, and there is no wind there at all. A poet named

Mr. Coleridge once wrote a poem about a ship that got into the belt of calms and could not move for a long time.

Day after day, day after day,
We stuck, nor breath nor motion;
As idle as a painted ship,
Upon a painted ocean.

In the poem a water sprite comes and takes the ship out of the place where there is no wind, or it would have stayed there forever.

There is an old English nursery song about the wind that tells just about what everyone there thinks about all the different winds.

When the wind is in the north
The birds and beasts do not go forth.

When the wind is in the east
'Tis neither good for man nor beast.

When the wind is in the south
It blows the bait in the fishes' mouth.

When the wind is in the west
Then the fishes bite the best.

The east winds often bring rain. The south winds bring the warmth in the spring. The north winds bring cold and snow, but the west winds are often pleasant and bring fair weather and cloudless sky.

How many winds are there?

There are dozens of different kinds of winds. They have many names. Breeze, gale, hurricane, cyclone, tornado, are all names of various winds. A light breeze goes only two or three miles an hour; a strong breeze may go ten miles an hour. A strong wind will go as high as twenty miles an hour. When the wind blows thirty or forty miles an hour we call it a gale.

Hurricanes go seventy-five miles an hour, as fast as a very fast automobile. When an automobile going that fast strikes something there is a terrible accident. When wind going that fast strikes trees and houses it tears them up and carries them away and makes terrible destruction everywhere.

Where do hurricanes strike?

Hurricanes come only in warm spots of the country. There have been very bad ones in Cuba and in Florida, and in the Philippine

Islands. They are just very strong winds blowing straight from the sea onto the land. They are caused by the water getting hot, so that the air over it rises very quickly and the cold wind over the sea rushes in to fill the empty space left by the rising air.

A great many times a high wave in the sea is blown along with the wind, and the water comes up over the land and causes as much damage as the wind does. About eighty years ago a hurricane and a wave blew over the Gulf of Mexico and buried under water several islands. On one of the islands was a big hotel full of people. They were all drowned and their bodies were found along the coast, sometimes a hundred miles away from the island.

A tropical hurricane

North America is in the region of the western winds. The wind blows most of the time from the west or southwest. A great many things interfere, so that there are days when the wind comes from the north or the south or the east, but when the winds for a whole year are counted, it will be found that the winds have

What wind blows most in North America?

come from the west or southwest for about six months out of the year.

In different countries they have names for some of their winds. In India there is a wind that blows from the south in summer and from the north in winter. In the winter the winds have come from the north where there are deserts, so that they do not bring any rain to India. The summer winds from the south have blown over warm oceans and they are full of moisture which falls on the land making it fertile. Thus they have two seasons in India, a rainy and a dry season; the wet time is in summer and the dry season in winter. They call this wind the monsoon, which is the Arabian word meaning season.

If the winds that blow from the south do not lose all of their water before they reach the high Himalaya Mountains that are the northern boundary of India, they lose it then. These mountains are so high that there is always snow on their tops. The winds have to go up five miles to go over them. As they go up they get

cold and the water turns to rain and falls. The south slope of the mountains is the wettest place in the world. Sometimes forty-two feet of water falls there every year.

What winds do other countries have?

The sailors in the Pacific Ocean are very much afraid of a wind that they call a typhoon. The name comes from a Chinese word "tai-fung," meaning storm. These always blow from the east. They are strong winds that whirl around very fast, as fast as a hurricane. Any ship that is in the path of a typhoon might be wrecked. Sometimes they blow over small islands that are in the path of the storm and do enormous damage.

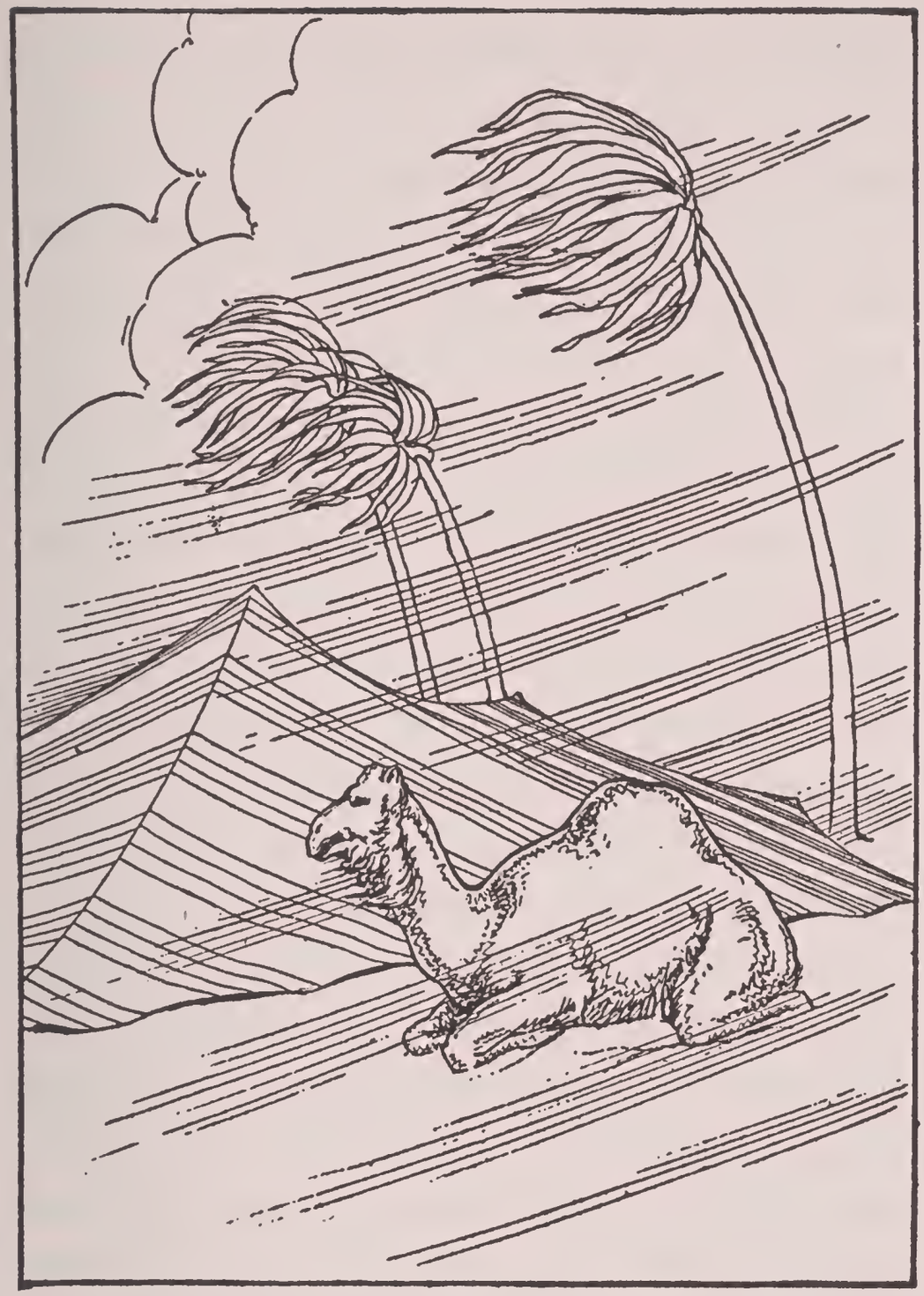
In Italy and Greece there is a wind that the people call the sirocco. It blows from the south and is very hot, so hot that often it burns up the plants and the leaves on the trees. It often has sand and dust from the deserts in northern Africa in it. It blows all night and all day for weeks at a time and makes the countries hot and dry and unpleasant.

In the great deserts of Africa and Arabia a

hot dry wind sometimes blows which they call the simoon. It blows so fiercely that it takes up clouds of dust and sand along with it. When a caravan crossing the desert gets caught in a simoon they can hardly breathe because of the sand in the wind. The men have to get off the camels and cover themselves with blankets to try to keep the sand out. Sometimes whole caravans are covered with sand and suffocated.

The reason that there is the great desert, the Sahara, in northern Africa, is that the winds that strike that part of the continent blow over great stretches of land before they reach there. They have lost all their moisture and there is none to fall on the desert. Occasionally a cloud will come over the desert and rain will fall, but it never reaches the ground. The air is so dry that it dries up the rain before it reaches the earth. People standing on the ground can see the rain coming in the sky, but they never feel it, for it does not get to them.

In the Rocky Mountains and in Canada there is a hot, dry wind that blows from the south in



The camels have a thin skin they can draw over their eyes to shut out the sand

the spring. The Indians called it the chinook, meaning snow-melter. It makes the snow disappear in the spring and the people are always glad to feel it come. In Germany they call the same wind the "schneefresser," which means "snow-eater" in their language.

What makes cyclones?

Most people get cyclones mixed up with tornadoes. They are not the same thing at all. Cyclones are great circles of wind sometimes one thousand miles across. They are caused by the changes in the weight of the air in warm and cold places, just like any other winds. They go in a great circle. Sometimes part of the circle will go faster and cause a hurricane. Sometimes a bit of it strikes a cloud and we have a rainstorm. When the cloud is filled with tiny bits of electricity there may be a thunderstorm. But the great cyclone keeps on going. The circle may go over an ocean, or over the whole of the United States. Very often it is nothing but just a gentle breeze going about ten miles an hour.

The wind in the cyclone carries clouds along with it. The weather man can tell where the

winds go, and so can predict rain will fall in a certain place.

In the center of the great circle, for cyclone means air going in a circle, there is always strong wind. The wind is less strong at the outside edge.

What is a tornado?

A tornado is the most terrible storm in the world. The only good thing about it is that a tornado does not cover much ground. One may be so small that it goes for only ten miles and has a path about three blocks across. But in that little space it will tear up trees, carry away cows and horses and automobiles, pull houses to pieces, and kill people. The storm may be over in ten minutes, but it may do millions of dollars worth of damage.

A tornado is a funnel-shaped cloud whirling round and round so fast that no one has ever been able to measure how fast it goes, and traveling forward rather slowly. Inside the funnel some men have thought that the cloud was going at a speed of four hundred miles an hour, faster than any automobile or airplane has

ever been able to go. It goes so fast that heavy objects like cows and automobiles have been picked up and carried for miles high up in the air. When the cloud stopped whirling the things were dropped and killed or destroyed.

Usually the funnel goes along the ground pretty slowly, so that if people see it coming they can often get out of the way. Not long ago a tornado came up in Kansas. It was seen coming several miles away and the brave telephone girl of the town that was in its path called up the people in the town and warned them to get out of the way. They got into automobiles and drove outside of the town about a mile. The storm came and tore down the houses in the little city, but the people a mile away felt nothing but a wind. The funnel was traveling so slowly that it did not strike the town for ten minutes after it was first seen.

In Iowa and Arkansas and other western states tornadoes are fairly common. The people in the districts where they strike often build tornado cellars either under the house or near

it. When they see a storm coming they go into the cellar, because the storm never harms anything that is underground. They take an axe along to cut their way out if something should be torn down on top of them.

Tornadoes come only in hot weather and always in the day time. They always come after it has been very hot and still. Men in the states where they are common can tell when they are apt to happen. The heat makes the air rise very fast, leaving a place where there is very little air at all. For some reason the cold air does not come in to fill the empty place as fast as it should. Then, when the wind does start to pour in, it comes from both sides very fast. When the two winds meet they whirl around in a funnel-shaped cloud. The cloud gathers up so much dust and dirt that it looks black. All the air along the ground is sucked up into the funnel, until it looks like a great black cloud with a pillar reaching to the ground. It travels along the ground at about thirty miles an hour, so that any automobile could keep

A tornado is terrible and dangerous

ahead of it, but inside the winds are going at a tremendous rate.

The tornado makes a terrible roaring noise, like a great waterfall. Whole trees have been torn out of the ground and carried for miles. The feathers have been plucked from chickens by the force of the wind. Men have been picked up and carried up into high trees or for miles along the ground and then dropped and killed. A tornado never lasts very long, from half an hour to an hour. When the cloud of wind gets warm it rises and the winds finish blowing up in the air so high that they do no damage on the ground under them.

When a tornado happens over the ocean it picks up water instead of dust and dirt and the sailors call it a waterspout. They do not happen very often on the ocean because the ocean does not have very hot places.

Chapter VI

THUNDER AND LIGHTNING

LIGHTNING is the same thing as the light in an electric lamp. It is electricity. There is a very little bit of it in the light bulb, but in one flash of lightning there is twenty times as much electricity as all the people in the world use in a day and a night. Nature wastes a great deal of her electricity, because there may be a hundred flashes of it in a single storm, and there are nearly two thousand thunder storms going on all over the world every minute of the day.

What is lightning?

Benjamin Franklin was a famous writer of wise sayings. He wrote:

"Early to bed and early to rise
Makes a man healthy, wealthy, and wise."

"A stitch in time saves nine."

"Two people can keep a secret, if one of them is dead."

He was the American statesman sent to France during the Revolution, when we were trying to get free from England. He was wise enough to get the French to send us soldiers and ships to help us in our fight with England. But Mr. Franklin was interested in other things than wise sayings and soldiers to fight England. He was interested in finding out why so many strange things happened in the world every day. He wanted to know if the electricity that he made with a cell in his workshop was the same thing as the lightning that he saw in the sky during a storm. He had an idea that the little spark that he could make was the same thing as the big spark in the cloud.

Franklin flew a kite

In 1752, fifteen years before he went to France to get help for the Colonies, he tried to find out about the lightning. He made a kite and fastened an iron key to it. When a thunder storm came up he went out and flew his kite up toward the cloud. People tried to stop him, for they thought that he would surely be killed by the lightning.

He knew that if the lightning was the same thing as electricity the key would attract some of it. He was right. The key was struck by a little flash of lightning and the shock traveled down the wet string to his hand.

What makes the lightning flash?

When the moisture in the air condenses on a tiny grain of dust, in some way the little drop becomes charged with electricity. That is, some of the electricity that is always in the air, gathers on the little drop of water. Then when the air gets cold and the drops go together to make rain drops some of the electricity cannot stay on the drops because there isn't room for it and it has to get off. When millions and millions of drops of water are pushing off little bits of electricity it all goes together and makes up one big flash of lightning. The big flash of lightning is really just millions and millions of tiny little ones.

Lightning flashes are crooked

Flashes of lightning may go from one cloud to another or they may go to the ground. When they go to the ground they sometimes strike trees and split them open. Sometimes they hit a house and set it on fire. It may hit a wire

fence and travel along the wire just as electricity travels along a wire to a lamp. If cows or horses are leaning on the wire in a pasture they may all be killed at once.

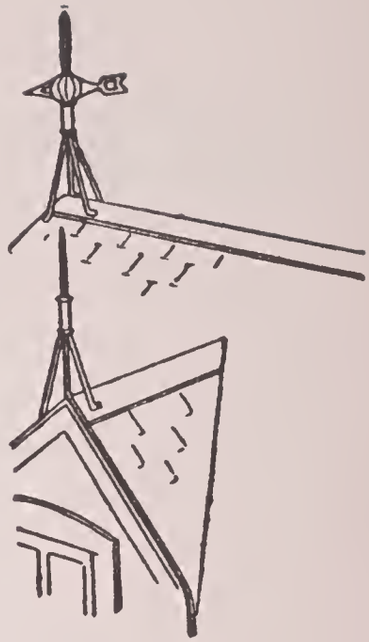
The lightning may strike a man and kill him. The lightning is very hot, so that when it strikes a house the heat may start a fire there. If it hits a tree the great heat turns the sap into steam so quickly that it must escape and it splits the tree open.

What are lightning rods for?

To protect their houses from the lightning farmers put tall rods up on the roofs of their houses and barns. These rods are connected to a wire that runs into the ground at the side of the building. People used to think that the rods attracted the lightning and it struck the rod instead of the roof and the rod carried it through the wire down into the ground. This is not what happens at all. The rod helps to make the lightning strike somewhere else. There is electricity in everything. It is in the ground. That which is in the ground comes up through the rods and goes into the air. The lightning

does not want to strike in a place where there is other electricity coming out, so it goes somewhere else to come down.

The safest place in a thunderstorm is in the house. There are a lot of queer old ideas about storms. Open windows do not attract lightning as people used to think. Beds are no safer than chairs. A closet is no safer than anywhere else in the house. Not one person in a million is killed by lightning. No one need to be afraid of it. Very few houses are ever struck.



Lightning rods protect barns and houses

Out of doors the safest place is not under a tree, for trees are often struck. Any tall object may be hit. In open fields and mountains men have saved themselves by lying flat on the ground. Although it is the most powerful thing in the world, lightning seldom does any damage. There is no reason for people to be afraid of it. If it could be caught and saved it would turn all the machinery in the world and no one would ever have to work.

The lightning does not make any sound. It makes the bluish light that everyone sees, like

What makes the thunder growl?

the light of a million lamps all put together. But along with the flash comes a long roll of noise, which people call thunder. It is sometimes so far off that it is just a faint mutter; other times it is so close overhead that it sounds like cannons going off one after the other, so loud and close that they shake the house.

The noise of the thunder is what frightens people more than the flash of lightning, although the thunder could not possibly do anything any harm. Before people knew what made the thunder they often made up stories about it. The people of Norway many years ago said that one of their gods, Thor, had a great hammer which he threw across the sky at his enemies. It went so fast that it made the flash of lightning. Then it returned to Thor's hand of its own accord. The noise of its striking was the thunder.

There is a story that up in the Catskill Mountains in the state of New York some men roll iron balls at ninepins. The rumble of the balls is the thunder. A Dutch explorer, Hendrick

Thor threw his hammer at those he hated and made the thunder and lightning

Hudson, sailed up the Hudson River long ago looking for a passage to China. They sailed down again without finding it. The people who live around that part of the country still say

Henry Hudson and his men play ninepins up in the hills when it thunders and lightnings

that it is Hudson and his men who are playing the old Dutch game in the hills that makes the noise of the thunder.

When the lightning goes through the air it pushes the air away. After it has gone the air rushes in again to fill up the hole. It is the air rushing in that sets up great waves like sound waves that we hear and call thunder.

The sound of the thunder does not reach us

until some time after the lightning flash because, although they are made at the same time, the light waves travel thousands of times faster than the sound waves. We can tell how far the lightning is away by counting the seconds it takes the sound of the thunder to reach us. If it takes the sound five seconds to reach us the lightning was a mile away. If it takes ten seconds the flash was two miles away. Before the sound reaches us the lightning has already struck somewhere. Lightning always goes in crooked zig-zag flashes.

Sometimes we can see lightning, but hear no thunder. The lightning is very far away and the waves of sound have become very weak before they reached the earth and have been caught by the warm air coming up from the ground and carried up again.

Thunderstorms usually come in the afternoon or evening, and sometimes at night. A thundercloud can always be told by its heavy grey and purple look. Just before it starts to rain a cold wind will come. This is cold air driven

in front of the cloud. Thunderclouds are always close to the earth, sometimes not more than a mile up. Airmen can fly over them and see the sun shining on the top. People high up in the mountains can see the storms down along the side of the mountain and hear the thunder and see the lightning while the sun is shining brightly around them.

What are the northern lights?

Explorers who have gone to the north and south poles tell about a lovely sight that they see in the nights in March and October. An arch of bright colors comes over the pole in the north and the south. Red, green, yellow and white lights dance and flash and light up all the land for hundreds of miles. These lights make it as light as day in countries where there is a night six months long.

No one has found out just what makes the beautiful colors. It is caused in some way by the electricity in the air, but that is all that anyone knows about it.

One of the best stories about anything in nature that men do not understand is the one

that the old Northmen told to explain the northern lights, which can be plainly seen from Norway on the long winter nights.

Odin, the king of the gods, lived in a palace called Valhalla. He was at war with the terrible giants who had lived on the earth before men came. In order to get brave warriors for his battles he sent his maidens, who were called the Valkyries, to the battlefields on the earth. They chose the bravest fighters who had been killed in war that day and brought them home to Valhalla.

The Valkyries rode great horses and were dressed in suits of armour. It was the lights flickering off their coats of mail and from their shields that made the northern lights. They carried the dead soldiers in front of them on their horses across the bridge of the rainbow to their father's hall, where he made them live again to fight for him. We call the northern lights the Aurora Borealis.

In Norway the weather is often more severe than in other countries because it is a land of

mountains and is very near the sea. They have thunderstorms in the middle of the night and sometimes in the winter. Both of these storms are very severe, especially the winter thunderstorms. In America the thunderstorms seldom come in the winter, just an occasional one in November or February. We do have them at night, also, but they come oftener in the hot part of the day. If they come in the evening they usually clear away and the stars shine again before very long.

Cloudbursts come from the clouds that look like ordinary black thunder clouds. Lightning plays through them, and then something happens, no one knows exactly what, and they drop all the water they are carrying at once. Usually this happens when the cloud floats against a mountain. So much water coming down all at once sometimes starts a landslide on the side of the mountain, causing much damage to the villages in its pathway.

Chapter VII

BALLOONS AND AIRPLANES

EVER since people saw that birds could fly in the air without falling they have wondered if people could not learn how to do it, too. In old books there are stories of men who have tried to fly. Hermes, the messenger of the gods, had wings on his heels and on his helmet and could fly through the air. Perseus was given winged shoes so that he might fly to the country of the terrible Gorgons and bring back the head of Medusa. A young man named Icarus was shut up in a castle. He gathered the feathers from the wings of the birds that flew over his prison. He put them together with wax and made wings for himself and his father. When the wings were finished he fastened them on their shoulders and they flew away over the sea. His father reached Sicily safely but the

Why does a kite stay up in the air?

boy wanted to show how well he could fly and got too close to the sun and the heat melted the wax, so that he fell into the water and was drowned. His friends said that the gods were angry because he had tried to fly, when the gods were the only people who should have the right to fly through the air on wings.

A gay Chinese kite

People flew kites for a long time before they thought of making machines to fly in. A kite is a very light framework of wood covered with paper or cloth. It may be shaped like a triangle, or a diamond. In China grown people as well as children make and fly kites. They have a great festival of kites every year. They are very lovely there. The kites may be made of silk, and may be shaped like dragons or like flowers, and are gaily colored.

Strings are fastened to the corners of the framework and a tail is attached to one end. The tail helps to keep it straight up in the air. A kite can only be flown on a day when there is a fairly strong wind. The wind is strong enough to push the weight of it up into the air. If the

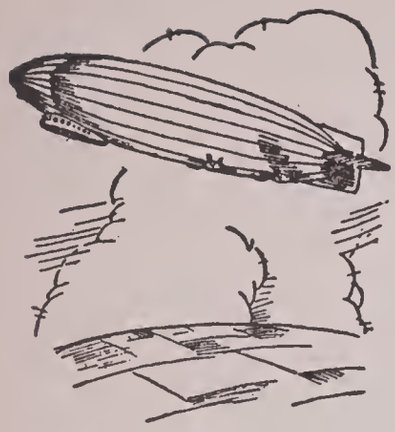
owner does not hold onto the string the kite would fall to the ground very soon. It takes the push of the wind on the paper and the pull of the string against the wind to keep the kite up.

Long ago people found out that there were some things that were lighter than air. That is, the weight of the air on top of them was not as great as the pressure of the air underneath. When this was true the feather, or piece of tissue paper went up instead of falling to the ground.

Why does a balloon go up?

There are some gases that are so light that if a bag is filled with them the gas will carry the bag up with it and even the weight of a basket with a man in it. At first people thought that it was wonderful to make a balloon that would carry up a man in a basket. When the man wanted to come down, he let some of the gas out of the bag. When there was not so much gas to keep it up, the balloon settled slowly down to the ground.

Now there are great balloons made and filled with a new kind of gas that is light enough to keep up with a cabin filled with thirty or forty



The great German Zeppelin

people. There are engines attached to the enormous machine that guide it wherever the captain wants to go. In 1929 one of these great machines went all around the world in eleven days flying time. They call this kind of a balloon a Zeppelin, after the name of Count Zeppelin, a German inventor, who first made them. The gas in the Zeppelin is hydrogen.

How does an airplane stay up?

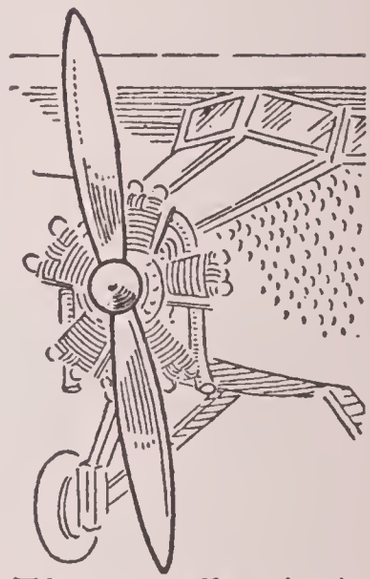
An airplane is not like a balloon. A balloon stays up in the air because it is lighter than the air. An airplane is heavier than the air and would fall at once if there was not a way of keeping it up. The twisted piece of wood, like two canoe paddles fastened together, in the front of an airplane is what keeps it up in the air. They must be going round and round very fast to do it. If they stopped going for a single minute the machine would fall.

This piece of wood is called the propeller of the airplane. It is connected to the engines in the front of the plane. The engines keep it turning very fast, thousands of times a minute. As it turns it makes a great wind, which blows

back against the wings of the plane. It is that wind that keeps the airplane up in the air and drives it forward. It is the same thing that keeps the kite in the air except that the airplane makes its own wind.

How does the airman guide the plane?

The airman has only two levers to guide the machine with. One of them turns the rudder on the back of the ship. This rudder is just like the rudder on a boat. This he works with his feet. The other one is called the "joy-stick" and he works it with his hands. This tips the edges of the wings and the tail surfaces.

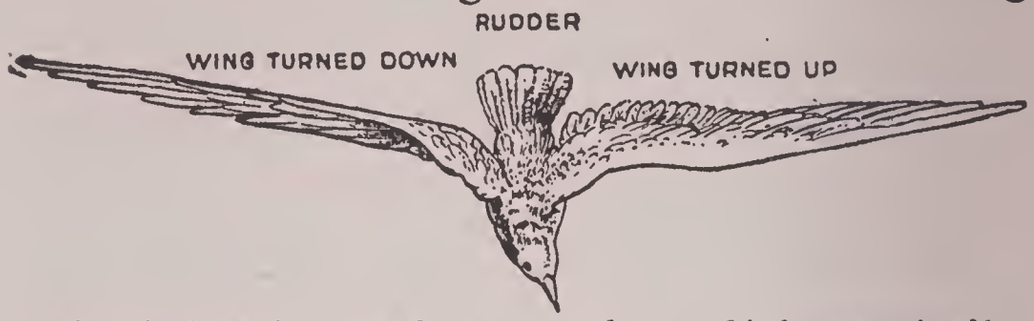


The propeller is in front

An airplane flies very much the same way a bird does. The bird has to flap his wings in order to get the wind under them to keep him up, but when he wants to turn he changes the position of his tail, which is his rudder, and bends his wings just as the pilot in the plane bends the wings and tail of his machine.

The bird finds it hard to fly in very stormy weather and he has to watch out for "air pockets," little places in the air where the air is moving in another direction.

A pilot always lands into the wind, so that when he shuts his engine off and is not making

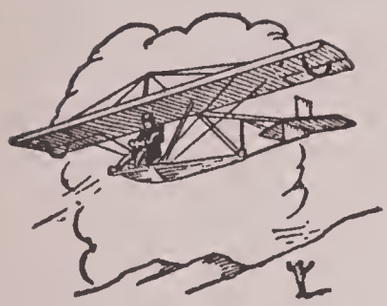


An airplane is steered very much as a bird steers itself through the air

any wind for himself the real wind will keep him up until he gets to the ground.

What is a glider?

A glider is built without an engine. It has wings and a tail to help steer it, but the man in it depends on the real wind that is blowing or the upward air currents on a still day to keep him up. He starts from a high place or gets someone to pull him along the ground until he gets up some speed and then tries to see how far he can go before he has to come down to the ground. Some men have stayed up for hours in a glider.



When was the first airplane built?

The first airplane was built in 1903. On December 17th, of that year, Orville Wright, who lived in Dayton, Ohio, flew a plane for twelve

seconds. It was the first time that a machine heavier than air had ever flown in the air. People laughed at Orville Wright and his brother, Wilbur, for thinking that they could fly, but they kept on trying, and in 1908 went to Europe and gave flights for the people there.

When the Great War started in 1914 every nation in Europe wanted to make airplanes so that they could fly over the enemy's country and find out what he was doing, and drop bombs on him. More and more airplanes were built and many men learned to fly them.

When the war was over men went on trying to make airplanes that would be safer to fly in. They tried longer and longer trips in them, until two men, Ross Smith and Keith Smith, flew from England to Australia and Charles Lindbergh flew from America to France in thirty-seven hours.

Now the mail is being carried all over the world by airplane. Passengers ride on them—not across the ocean as yet—but that may happen, too. Freight is being carried on them.

It seems as if the prophecy that Mr. Tennyson, a famous English poet, made fifty years before the first airplane was built has come true.

"For I dipped into the future, far as human eye could see.
Saw the Vision of the world, and all the wonder that would be;
Saw the heavens filled with commerce, argosies of magic sails,
Pilot of the purple twilight, dropping down with costly bales."

How does the airman know where to go?

The weather is the most important thing that an airman has to know about. He can steer his ship all right in a fog, but he cannot see where to land, and so he may run into a tree or a building. Wireless messages are used to help guide the pilots. They have all kinds of compasses in their ships to help them find the way. Much of the time they fly close enough to the ground so that they can see where they are going and where to land.

Within the last few years beacons have been put up to guide the pilots who travel at night. These are high towers like windmills

with a light in the top that goes around in a circle. The lighthouses along the ocean are put there to warn the sailors away from the dangerous rocks, but the light towers for the airmen on land are put there to show them where it is safe to go and safe to come down.

All of the tall buildings and electric light poles are having lights put on them these days to keep the pilots from running into them at night. The time may come when there will need to be traffic policemen in the sky.

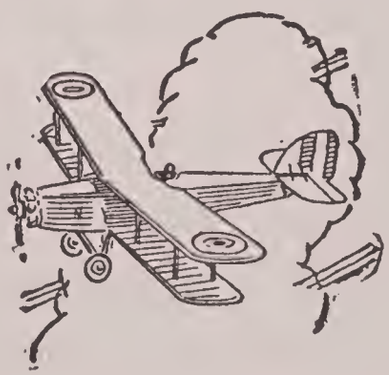
More and more airplanes are being built every day, and more and more boys and girls are learning to fly planes. They are not entirely safe yet. This is because airplanes are still new to us and we have not been able to make them as perfect as they should be. Some day inventors may find ways to make airplanes as safe as automobiles are.

There are many different kinds of airplanes. One kind is made to land on the water. It is sometimes called a seaplane. When they come down on the water of a lake the spray

dashes up around the plane, but the machine sits on the water as lightly as a bird.

Some planes have one wing and some have two. They have different names, like monoplane and biplane. The famous airplane that Charles Lindbergh flew on his trip across the Atlantic Ocean was called the "Spirit of St. Louis," because the men who gave Colonel Lindbergh the money to make his trip were men who lived in St. Louis.

Most of the airplanes have two wheels in front with tires like those on automobiles. The airman tries to land on the ground so that he touches with the two wheels and the tail all at once. They are not so likely to tip over in landing if they do. They call it a "three-point landing" if they strike all of them at once.



Chapter VIII

THE WEATHER MAN

FOR a long time men have known that some things got larger when they got hot and smaller when they were cool. In 1714, a German student named Fahrenheit thought of using that fact to measure heat. He put some mercury, a heavy liquid that looks like silver, but will pour like water, into a glass tube with a little bulb on the end. First he put the bulb in ice and marked the place where the ice melted into water. That he called 32 degrees, or freezing point. Then he put it into water and when the water boiled he marked it 212 degrees; and he called that boiling point. Then he divided the space between into 180 degrees.

How does the thermometer tell how hot it is?

We use this thermometer in the United States and England more than any other. Zero is thirty-two degrees below freezing point, so that

when it is at zero or below, it is very cold. There is another thermometer, the centigrade. On it the boiling point is at 100 degrees, and the freezing point is at zero. It is used in France and men who are studying about heat use it because it is easier to do problems with.

What does the word thermometer mean?

The word thermometer means measure of heat. That is just what it is for—to measure the amount of heat in the air, or in anything else. Thermometers are put on the ovens of stoves so that the cook can tell just what is the right heat to bake her cakes and pies and roasts in. Cream must be at just a certain temperature to churn into butter quickly and easily. Plants need a certain amount of heat to grow in greenhouses. The baby's milk must be just so warm, or the baby may get sick. Little chicks will not hatch from the eggs in an incubator unless it is kept at a certain temperature. Houses should be kept about seventy degrees in the wintertime so that the people in the house will be well and comfortable.

A thermometer measures heat

The weather men keep careful account of the

heat each day. They can tell what sort of weather to expect by using the thermometer and barometer every day.

Wind is caused by having one part of the air on the earth heated so that it rises into the sky. As it rises other air must come to take its place. Often the new air that comes in brings clouds and rain with it. When air is going up there will be very little pressure of the atmosphere. The weather man will say that we are having a low pressure. When the wind is coming in the barometer will be high because not much of the air will be rising and the atmosphere will be heavy.

A barometer measures pressure

A barometer is a little instrument for telling how high or how low is the pressure of the air. If it is low the weather man says that it is likely to rain. If it is high there will not be any clouds brought in and the weather man will predict "generally fair" for the next day.

What is a barometer?

If the barometer falls very suddenly it means that a bad storm, maybe a tornado, is coming. The barometer has a column of mercury in a

tube about thirty inches high. When it stays up this high there is a high pressure; if it falls to twenty-eight or twenty-nine it is a low pressure, which means rain.

What makes the weather?

The sun makes all the weather. If it were not for the sun we would have no heat and cold, nor any winds or rains. But other things help to make weather, too. The mountains and the lakes and the oceans change the directions of the winds; the earth turning around pulls some of the winds out of their course. There are great currents in the water of the ocean that warm or cool the winds and make the weather different than it would be otherwise.

The weather man uses many instruments

England is an island washed all around with the ocean. It is directly across from Labrador, where it is very cold. It would seem that England should be very cold also, but it is not. It is seldom cold enough in England to freeze ice thick enough to skate on. They almost never have snow there, and the grass stays green all the year around.

The reason for this is that a great warm ocean

current comes from down near South America across the Atlantic Ocean, and washes the shores of England. This warm current makes all the winds that blow across it warm also. All the winds that blow across England have blown across this warm water first, so that they help to warm the island.

The mountains have much to do with the weather. They cool the winds from the sea, so that all the rain in their clouds falls on one side of them. One side of a mountain range may have a great deal too much rain, while the other side is a desert. Sometimes the winds do not go over the mountains, but are turned aside.

Men have studied the weather for so long that they can almost tell by watching the thermometer and the barometer and the direction of the winds just what the weather is going to be the next day.

There are a lot of old beliefs about the weather. Some of them are silly. For example, the old saying that potatoes should be planted the Friday before Easter is not true. The Friday

before Easter may be a bitterly cold and snowy day. Many farmers used to believe that corn should be planted in the dark of the moon, but now they know that the time to plant corn is when the ground is ready and the weather is warm. People do not think any more that the moon has very much effect on the weather. There is an old saying that when the horns of the new moon tip up so that a pail could be hung on them, the month would be dry, and if the horns of the new moon were tipped down the moon would not hold water and so the month would be wet.

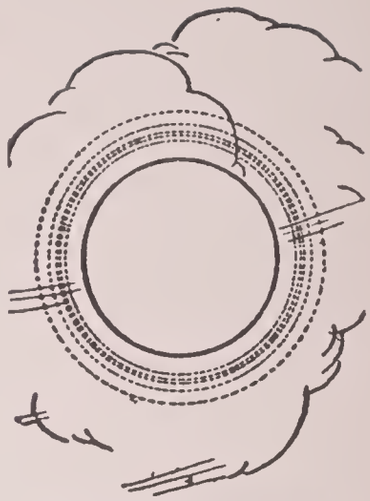
Some of the old weather ideas have been shown to be true. When men said,

"Rainbow in the morning, sailors take warning,
Rainbow at night, sailors' delight"

they meant that if it rained early in the morning, it would probably keep it up all day, but if it rained at night it would clear up during the night and the next day would be fair.

Rings of light around the sun and the moon are very likely to come before stormy weather,

because they are formed by clouds. The Indians used to say that if the fur on the foxes was thick it meant a long hard winter. Farmers sometimes say that if the husks of corn are thick it means a long winter. Many people believe that if the groundhog sees his shadow on the second of February, there will be six weeks more of cold weather, and if he does not see his shadow then that spring will come at once. There is a belief that if it rains on Easter, it will rain for the next six Sundays.



Rings around the sun

How does the weather man tell about the weather?

Every day in the newspapers there is a weather report. It tells when the sun will rise and set, when the moon will rise and set, what the temperature and the pressure has been for the last day, and it foretells what the weather is going to be like for the next day. This news is very useful to many people. The fruit growers can tell when to protect their trees. The farmers can tell when to begin planting in the spring. Aviators can tell what kind of weather they must prepare for when they start off on a flight. Sailors can stay in port if the weather is

going to be very bad. People going to work can tell whether to take their heavy coats or umbrellas. People going on an auto trip or a picnic will not go if the weather man says that it is going to be cold or rainy weather. Sometimes the report is wrong, but more often it is right, and is of great importance.

Who is the weather man?

The government of the United States has a Weather Bureau in Washington and about two hundred weather stations all over the country in all the biggest cities. The men in charge of the stations have studied about the air and the weather. The station has all sorts of machinery to help the weather man. There are machines to tell the direction and the force of the wind, to measure the amount of rainfall and snowfall, to measure the heat of the sun, and to tell the weight of the air. Twice a day the weather man takes all these measurements and puts them down on a weather map.

He sends these measurements to Washington every day and gets back from Washington news from all the other parts of the United States

about the weather. If there is a bad storm from the west coming toward the east he will know it and warn the people in his part of the country. Because he has studied the weather for so many years he knows just what kind of weather will come after a day of east wind, or what weather to expect when there has been a heavy thunder shower followed by cold weather.

Can we do anything about the weather?

The weather may be a friend to man in a great many ways, but it is often harmful to him. When men first lived in forests, probably up in trees, the weather was warm and they did not need to be sheltered from it, but as it grew colder they had to come down from the trees and go into caves to keep warm.

So men won their first victory over the weather when they learned to live in places that would keep out the cold and the rain and wind. But it kept growing colder. Some of the men went further south and found warmer weather, but many of them stayed and tried to live where it was cold. Then they learned to make themselves clothing out of the skins

of wild animals. That was another victory in the war with the cold. After a time they found out how to keep a fire going near the mouth of the cave and then they had won the war, because as long as there was wood to burn they could keep warm no matter how cold it got.

The animals have to fight the weather, too. They grow thicker skins and longer fur to protect them from the cold. Some of them go south during the winter. A great many of the birds do that. Some of them sleep all winter as the bears do. The snakes and frogs and turtles bury themselves in the mud and stay all winter. The fish live under the ice in the rivers and the lakes. Some animals, like the wolves and the foxes, find dens out of the wind where they can stay when it is raining hard or snowing.

As soon as men found that fire would make light at night as well as give them heat in the day time they had another way of fighting the weather. They could do things at night with a light that before they could do only in the

day time. They first used the light of the fire. Then they made torches to light the great halls of their castles. Soon someone found out how to make a little oil lamp by floating a piece of cloth in a basin of fat. Then someone put the cloth in the center of the fat and made a candle. After Franklin discovered that electricity could be used for lights people began to use it in their houses. Now all of our towns are lighted with electricity, in the streets and in the houses.

When men wanted to live in places where the weather was cold most of the year they had to find some way to grow crops there. They found new kinds of grain that would grow quickly and get ripe in a short time. They raised animals that could live in cold climates and so won the battle with the weather again.

Because men have had to build houses to keep out the cold they have learned to build beautiful ones. Men called architects try all the time to make more comfortable and more beautiful homes. Artists try new ways of making the homes lovely inside so that people will

like to stay in them on the days that the weather is too bad to be out of doors.

Other men have tried to find ways to amuse people in the times that it is too cold to be outside. They have invented motion pictures, and music for men to see and hear, and have written books for them to read.

Parts of America have become what are called summer resorts and winter resorts. People go to California and Florida in the winter to get away from the cold in the north. They go to Canada and to the lakes and ocean to get away from the heat in summer. All over the country are railroads to help them go to these places and back again. Sometimes heavy rains wash out parts of these tracks in the summer or heavy snows block them in the winter. Men have learned how to protect them from washouts and have invented great plows to clear them of snow in the winter.

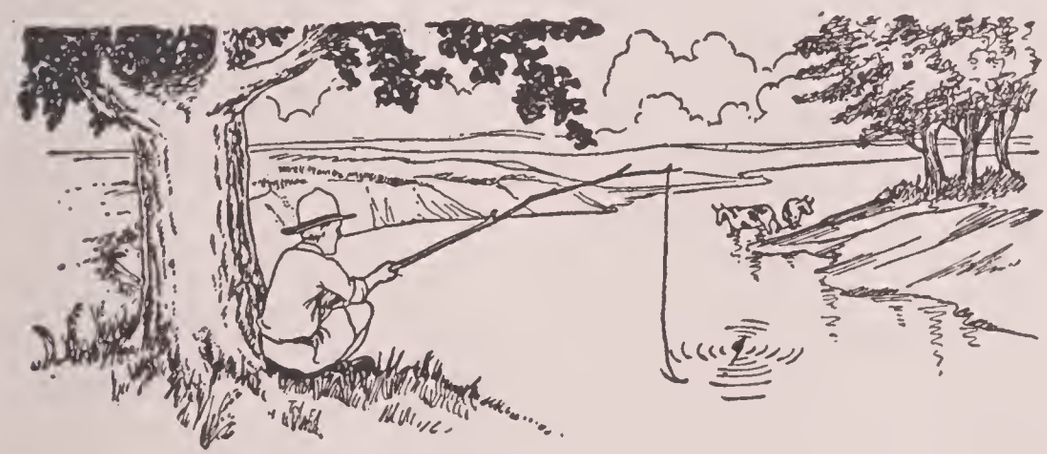
What good is the weather?

The weather is one of the most important things in the world. It brings rain to give us water to drink and to make the crops and

gardens grow. It brings snow to cover the fields so that the roots of the grass will not freeze. It bring the warm winds to make the corn get ripe. If the weather was the same always people would get very tired of it. People are very hard to satisfy about the weather.

Someone has made up a little verse about it.

As a rule a man's a fool.
When it's hot, he wants it cool.
When it's cool, he wants it hot.
Always wanting what is not.



Deacidified using the Bookkeeper process.
Neutralizing agent: Magnesium Oxide
Treatment Date: June 2013

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